

Impacts of Crop of Residues on Soil Moisture

By Margaret Caldecott

Have you ever been standing in your field in mid-July and wondered where all that spring moisture went? One way to conserve the spring water for later in the year when you need it is by leaving plant residues on the soil surface. The impacts of residue on soil water include changes to the energy balance (radiation and wind energy) and subsequent changes in soil temperature, alterations of the organic matter content, and erosion. The following text will provide information on how crop residue influences soil water and the soil water-holding capacity.

When we talk about changes in the soil's energy balance it sounds a bit technical but in this case it is as simple as changes in wind speed and radiation balances which lead to soil temperature differences and soil water changes. Crop residue on the soil surface can either be left standing or it may be lying down. In both cases, residue will increase the soil surface roughness, thereby slowing wind speed and lessening evaporative losses. When residue dries in the spring, a vapour barrier is established between the soil surface and the atmosphere which reduces the evaporation rate at the soil surface (Wilhelm et al, 2004). Furthermore, in the winter the wind drag generated by the residue can result in higher snow accumulation (Wilhelm et al, 2004). As a result, during spring thaw there is more snow melt which then increases soil water content. While this can slow spring field operations, it may provide more moisture mid-season for growing crops.

In terms of radiation balance, one researcher noted the influence of residue on the soil water regime before planting (Sharratt, 2002a; Sharratt, 2002b). Tall residues or small flat residue resulted in higher absorption of radiation by the soil (Sharratt, 2002b). This was due to the lower reflectivity or albedo of the tall standing residue and high absorption of solar radiation by the soil surface not covered by residue (Sharratt, 2002b; Andrews, 2006). Soil temperatures in tall standing residues or sparse flat residues are increased compared to short stubble or high quantities of prostrate residue which leads to more water evaporation from the soil profile. What does this mean for Ontario producers? Tall or sparse stubble may mean getting into your fields faster in the spring, but could mean smaller soil water reserves for your crops later in the spring or summer when they may need it.

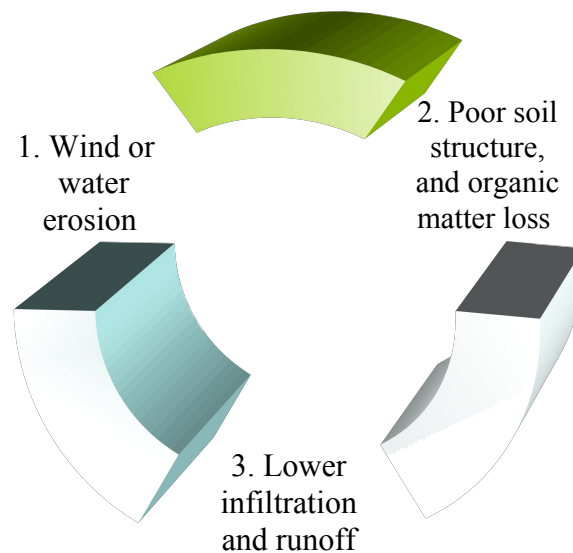
Another benefit of leaving crop residues on the field is increased soil organic matter levels and increased infiltration. When crop residue is left on the soil surface, microbes break down the plant matter into a rich material known as organic matter. One of the best known benefits of organic matter is its high nutrient content, but equally important is its ability to hold and store water. Soil with a higher level of organic matter has a higher percentage of micro- and macro-pores which allows it to store more water than soil low in organic matter. Also, organic matter reduces the bulk density of a soil (again due to higher pore content) therefore allowing for better infiltration of rainfall and snow melt (Andrews, 2006). In general, higher organic matter means greater water holding capacity and better infiltration.

One of the greatest benefits of residue is the reduction in soil erosion. This article will only discuss erosion briefly as another article looks at this issue in more detail.

Erosion mainly influences soil structure, stability, and texture and once erosion starts there is a negative feedback loop that occurs (Fig 1). Rainfall can cause soil suspension, overland loss of soil particles, and gullies. Leaving residue on the surface reduces rainfall impact and wind erosion. Preventing degradation of soil structure can increase the likelihood of water infiltration into pore channels and to depth in the soil profile (OMAFRA, 2003).

Past erosion can also lead to increased soil erodibility. Many exposed subsurface soils on eroded sites tend to be more erodible than the original soils due to poorer soil structure resulting from lower organic matter levels. Reduced nutrient levels in the subsoil also tend to result in lower crop yields which results in less crop cover for erosion protection (OMAFRA, 2003).

Figure 1: Negative feedback loop that occurs once erosion starts.



In summary, there are numerous reasons to leave crop residue on the soil surface, especially if increasing your soil's water holding capacity is your goal. Residue cover helps to prevent erosion and builds soil organic matter content which are good for your soil. In addition, it helps reduce evaporative water loss during windy, sunny days which can translate into yield benefits in many cases.

Notes:

Andrews, S.S. 2006. Crop Residue Removal for Biomass Energy Production: Effects on Soils and Recommendations. Found at http://soils.usda.gov/sqi/management/files/agforum_residue_white_paper.pdf

Sharratt, B.S. 2002a. Corn Stubble Height and Residue Placement in the Northern Corn Belt. Part 1: Soil Physical Environment during Winter. Soil and Tillage Research. 64: 243-252.

Sharratt, B.S. 2002b. Corn Stubble Height and Residue Placement in the Northern US Corn Belt. Part 2: Spring Microclimate and Wheat Development. Soil and Tillage Research. 64: 253-261.

OMAFRA, 2003. Soil Erosion: Causes and Effects. Found at <http://www.omafra.gov.on.ca/english/engineer/facts/87-040.htm>

Wilhelm, W.W., Johnson, J.M.F., Hatfield, J.L., Voorhees, W.B., and Lindene, D.R. 2004. Crop and Soil Productivity Response to Corn Residue Removal: A Literature Review. Agron. J. 96:1-17.